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(71) Applicant(s)
Lynton Lasers Limited
(Incorporated in the United Kingdom)
Lindow House, Beech Lane, WILMSLOW, Cheshire, SK9 5ER, United Kingdom

(72) Inventor(s)
Jonathan Alan Exley

(74) Agent and/or Address for Service
Alistair Hamilton
Ty Eurgain, Cefn Eurgain Lane, Rhosesmor, MOLD, Flintshire, CH7 6PG, United Kingdom

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(54) Abstract Title
Dermatological treatment apparatus

(57) Dermatological treatment apparatus for treating human skin with intense visible light is disclosed. The apparatus has a light source 40 within a cooling fluid duct 42, the cooling fluid duct 42 having a light transmissive region and a light reflective region disposed to reflect light from the light source through the light transmissive region. The light reflective region may be formed by a coating 54 applied to a region of the cooling fluid duct 42. Such a coating may, in preferred embodiments, include a reflective metal layer, and one or more additional layers. The light source may be flash lamp such as a xenon discharge tube. A control unit is typically included to provide controlled power to the light source.

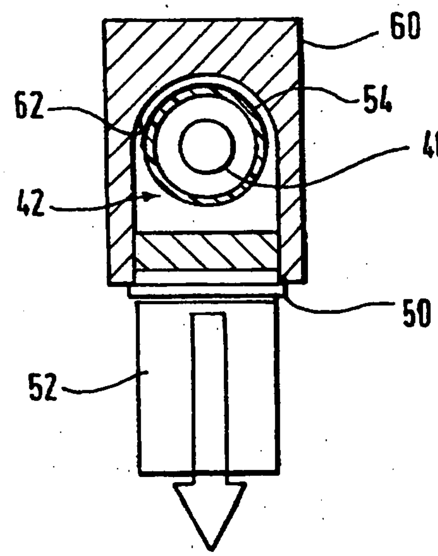

FIG.3.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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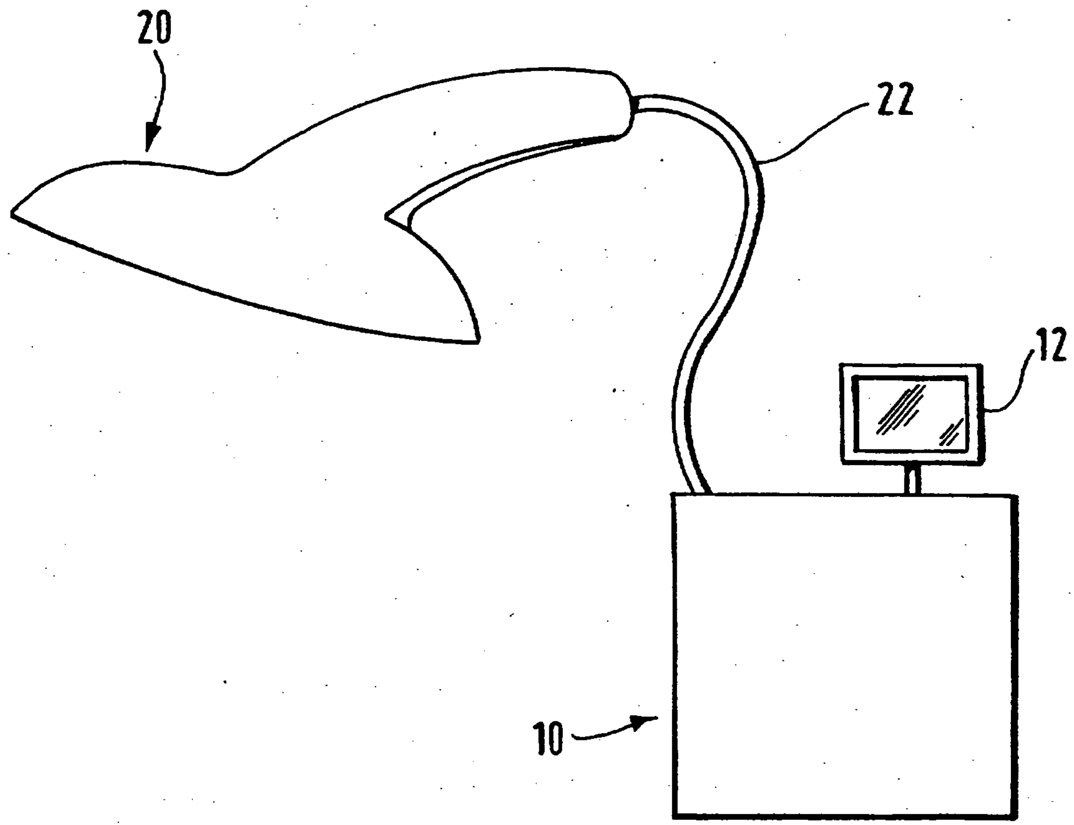

FIG.1.

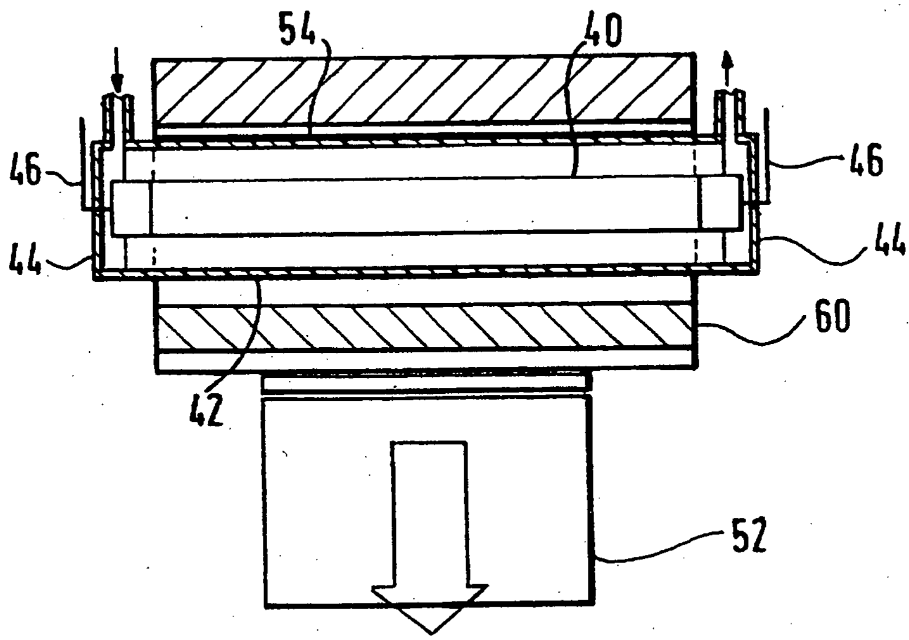

FIG.2.

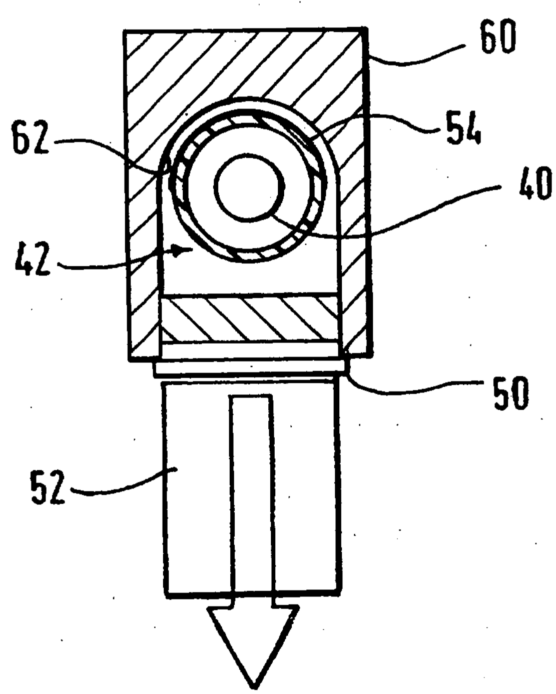

FIG.3.

Dermatological treatment apparatus

The present invention relates to dermatological treatment apparatus. In particular, this invention relates to apparatus for treating human skin using visible light.

It is known to treat conditions and perform cosmetic treatment of human skin using high-intensity visible light. For example, it is well known to erase tattoos and other skin pigmentation and to remove unwanted hair by application of high-intensity light to the skin.

One form of this treatment uses laser light. This can provide light that can be accurately directed and controlled by a practitioner to provide effective treatment. However, laser apparatus for carrying out such treatment is typically costly and, in many cases, requires a dedicated power supply; two issues that limit the availability of the apparatus and hence restrict access to the treatment that requires such apparatus.

An alternative type of apparatus is also known that uses high-intensity non-laser light, for example, as generated by a discharge tube. Unlike a laser, a discharge tube emits light in a wide range of directions, so the apparatus must typically be provided with a light control arrangement to direct light emitted from the tube towards a treatment site. In known apparatus, the light control arrangement may include a highly polished metal reflector. A disadvantage of this type of apparatus is that the tube emits a large amount of heat. For this reason, the discharge tube is typically disposed within a duct that carries a flow of cooling fluid, for example, deionised water. While this assists in removing heat from the apparatus, it can reduce the efficiency with which light can be reflected by the reflector so reducing the amount of light produced by the apparatus. Moreover, a substantial amount of heat may nevertheless be transferred from the discharge tube into the reflector, and, in turn, into components connected to the reflector. This can be especially disadvantageous where the apparatus is to be hand held by a practitioner, to whom the heat can cause discomfort over time.

An aim of this invention is to provide dermatological treatment apparatus of the general type described in the last-preceding paragraph that avoids or at least ameliorates disadvantages of known apparatus.

From a first aspect, the invention provides dermatological treatment apparatus having a light source within a cooling fluid flow duct, the cooling fluid duct having a light transmissive region and a light reflective region disposed to reflect light from the light source through the light transmissive region.

This arrangement provides a reflector that is straightforward to produce, that is compact, and that is efficient. In particular, it avoids the need to manufacture, and can omit the weight of, a separate reflector, which, in known systems, is typically formed from a highly polished metal body. Moreover, it ensures that the amount of heat that can escape from the cooling fluid duct into surrounding components is minimised, so restricting the amount of heat that can be passed to other components within the treatment head.

The cooling fluid duct is typically formed from a hard, heat-resistant, transparent material. For example, it may be glass. It might alternatively be quartz, a material that can be more resistant to heat. It typically has a tubular section. For example, it may be cylindrical, this being the simplest shape to produce. Alternatively, the cooling fluid duct may have a cross-sectional shape selected to confer advantageous optical properties upon the reflective region. For example, the cooling fluid duct may have a cross-section that is in part approximately or substantially parabolic to focus light emitted by the light source.

The light reflective region is typically constituted by a region of the cooling fluid flow duct coated with a reflective coating. The reflective coating may include a reflecting layer of metal, such as silver, aluminium, or a mixture of those and/or other metals. Such a reflective layer can readily be formed by various techniques, including, for example, vacuum deposition. The reflective coating may include one or more layers in addition to the reflecting layer. Such additional layers may, for example, contribute to

properties of the reflective coating. Those properties may include the physical robustness, the reflectiveness, the opacity, and/or the ability to disperse heat. For example, the additional layers may include a layer of paint to protect underlying reflective layers.

As a specific example, the reflective coating may comprise a layer of silver metal deposited upon the material of the cooling fluid duct, a layer of copper deposited upon the layer of silver, and a protective paint layer applied to the copper layer. Alternatively, the layer of copper may be omitted.

From a second aspect, the invention provides a dermatological treatment unit comprising apparatus according to the first aspect of the invention contained within a treatment head, and a control unit for controlling operation of the apparatus. In such a unit, the control unit may be connected to the treatment head by a cable through which electrical signals and/or cooling fluid is conveyed.

An embodiment of the invention will now be described in detail, by way of example, and with reference to the accompanying drawings, in which:

Figure 1 is an external view (not to scale) of a treatment head and a controller, being components of treatment apparatus embodying the invention; and

Figures 2 and 3 are diagrammatic side and end views of a discharge tube and associated components in apparatus embodying the invention.

With reference to the drawings, dermatological treatment apparatus embodying the invention includes a control unit 10 that contains electronic control components responsible for operation of the apparatus. The control unit 10 also has a user control panel 12 whereby an operator can control operation of the apparatus. A control unit of substantially convention construction may be suitable for use in embodiments of the invention. The construction of such a conventional control unit 10 is well understood by those skilled in the relevant technical fields, and will not therefore be described further.

A treatment head 20 is connected to the control unit 10 by a connecting cable 22. The treatment head 20 is a unit that can be hand held by an operator to apply pulses of high-intensity visible light to a specific treatment site on a patient's skin, for example, in treatment for removal of unwanted hair. As will be appreciated, the requirement for the treatment head to be hand held places a restriction upon the design of the treatment head 20 in terms of its maximum weight, maximum operating temperature, and many other requirements. The present invention is intended to assist in the design of a treatment head that has an advantageously low operating temperature, and can minimise weight. Most other of these requirements are not central to this invention, and will therefore not be discussed further.

Internal components of the treatment head 20 most relevant to the invention will now be described.

The treatment head 20 includes a flash tube 40. In this example, the flash tube is a xenon discharge lamp, capable of producing a train of high-intensity pulses of light of short duration. In this embodiment, the flash tube 40 is an elongate linear tube. The flash tube 40 is provided with a suitable supply of electrical power generated by the control unit 10 and carried to the treatment head 20 by the cable 22 in a manner well understood by those skilled in the technical field.

The flash tube 40 is disposed within a cooling fluid duct 42. The cooling fluid duct 42 is formed as a cylinder of transparent heat-resistant material such as borosilicate or cerium-doped quartz. During operation of the apparatus, a flow of cooling water is pumped through the length of the cooling fluid duct 42 to carry heat away from the flash tube 40. Deionised water may suitably be used as a cooling fluid. The cooling water is conveyed in a continuous circuit to and from the cooling fluid duct 42 by conduits 44 that connect it to the cable 22 and thence to a pump and to a heat exchanger contained within the control unit 10. Power supply lines 46 for the flash tube 40 are conveyed through suitable sealed apertures in the conduits 46.

Light emitted from the flash tube 40 is directed to the reflector through the filter element 50 and from there conveyed by a light guide 52 to an outlet window (not shown) of the treatment head 20. For use, the outlet window is placed in contact with an area of skin that is to be subjected to treatment.

In order to guide light emitted from the flash tube 40 towards the filter element 50, a reflective coating 54 is applied to a region of an outer wall of the cooling fluid duct 42. Light that is produced within the flash tube 40 may strike the reflective coating 54 to be reflected in a direction generally towards the light guide 52. The region upon which the coating is applied extends to such a length that it lies adjacent to the flash tube 40 along substantially the entire length that the flash tube 40 emits light. The reflective coating 54 extends around the duct to cover somewhat more than half of the extent of the duct 42; that is to say, when viewed from an end of the tube, the reflective coating 54 extends around the tube by an angle somewhat greater than 180°. The particular angle of coverage of the reflective coating 54 is selected to maximise the amount of light transferred from the flash tube 40 to the light guide 52. The precise angle is determined by the arrangement of a specific embodiment, and may be selected by experiment.

In this example, the reflective coating 54 includes several layers. A first layer is a reflective layer and is formed in direct contact with an external surface of the cooling fluid duct 42. The reflective layer is a layer of deposited metal, for example, silver metal, aluminium metal, or a mixture of those and/or other bright metals. The reflective layer is formed by vacuum deposition of metal ions onto the surface of the cooling fluid duct 42. As will be appreciated, the shape of the reflective layer, and therefore its optical performance, is determined by the external shape of the cooling fluid duct 42. This shape is selected to confer upon the reflective layer a shape suitable for optimising the transfer of light emitted by the flash tube 40 towards the light guide 52. Such a construction can provide a reflector of good optical performance with a minimum of cost and complication in manufacture.

A second layer is applied to cover the reflective layer. In this example, the second layer is a deposited layer of copper metal. On top of these metal layers, a protective coating

of paint is applied to provide protection to the reflective metal layers below. In a proposed alternative embodiment, the copper metal layer is omitted from the reflective coating 54.

The cooling fluid duct 42 and the flash tube 40 are carried within a metal (for example, aluminium) block 60 that serves to maintain all of the components in a fixed relationship to one another. Other components of the treatment head not shown in the drawings may also be carried on the block 60. A U-shaped slot 62 is formed in the block 60 to enclose the cooling fluid duct 42 and the flash tube 40 within. At its base, the slot 62 may optionally be shaped and/or polished to gather light that is not reflected by the reflective coating 54 and to direct that light towards the light guide 52. Cooling fluid ducts may be provided within the block 60 to carry a circulation of cooling water to remove heat from the block.

It will be understood that much of the radiant heat emitted by the flash tube 40 will be reflected by the reflective coating 54 and will therefore not escape the cooling duct to reach the block 60 or other components of the treatment head 20. This ensures that a treatment head 20 of apparatus embodying the invention is inherently less prone to become hot than is the case in conventional apparatus in which reflection is principally achieved by, for example, a highly polished region of the block 60.

It will be understood that the embodiment described above is presented by way of example only, and does not limit the scope of the invention. Moreover, each feature is disclosed in the description, the claims and the drawings may be provided independently or in any appropriate combination.

Claims.

1. Dermatological treatment apparatus having a light source within a cooling fluid flow duct, the cooling fluid duct having a light transmissive region and a light reflective region disposed to reflect light from the light source through the light transmissive region.

2. Dermatological treatment apparatus according to claim 1 in which the cooling fluid duct is formed from a hard, heat-resistant, transparent material.

3. Dermatological treatment apparatus according to claim 2 in which the fluid duct is formed of glass.

4. Dermatological treatment apparatus according to claim 2 in which the fluid duct is formed of quartz.

5. Dermatological treatment apparatus according to any preceding claim in which the cooling fluid duct has a tubular section.

6. Dermatological treatment apparatus according to claim 5 in which the cooling fluid duct is generally cylindrical.

7. Dermatological treatment apparatus according to any one of claims 1 to 5 in which the cooling fluid duct has a cross-sectional shape selected to confer advantageous optical properties upon the reflective region.

8. Dermatological treatment apparatus according to claim 7 in which the cooling fluid duct has a cross-section that is in part approximately parabolic.

9. Dermatological treatment apparatus according to any preceding claim in which the light reflective region is constituted by a region of the cooling fluid flow duct coated with a reflective coating.

10. Dermatological treatment apparatus according to claim 9 in which the reflective coating includes a reflecting layer of reflective metal, such as silver, aluminium, or mixture of those and/or other metals.

11. Dermatological treatment apparatus according to claim 9 or claim 10 in which the reflective coating includes one or more layers in addition to the said reflecting layer.

12. Dermatological treatment apparatus according to claim 11 in which such additional layers contribute to properties of the reflective coating, the properties including any or all of its physical robustness, its reflectiveness, its opacity, and/or its ability to disperse heat.

13. Dermatological treatment apparatus according to claim 12 in which the additional layers include a layer of paint that serves to protect underlying reflective layers.

14. Dermatological treatment apparatus according to claim 9 in which the reflective coating comprises a layer of silver metal deposited upon the material of the cooling fluid duct, a layer of copper deposited upon the layer of silver, and a protective paint layer applied to the copper layer.

15. Dermatological treatment apparatus according to claim 9 in which the reflective coating comprises a layer of silver metal deposited upon the material of the cooling fluid duct, and a protective paint layer applied to the silver layer.

16. Dermatological treatment apparatus according to any preceding claim in which the cooling fluid is water.

17. Dermatological treatment apparatus substantially as herein described with reference to the accompanying drawings.

18. A dermatological treatment unit comprising apparatus according to any preceding claim contained within a treatment head, and a control unit for controlling operation of the apparatus.

19. A dermatological treatment unit according to claim 16 in which the control unit is connected to the treatment head by a cable through which electrical signals and/or cooling fluid is conveyed.

20. A dermatological treatment unit substantially as herein described with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

Claims.

1. Dermatological treatment apparatus having a light source within a cooling fluid flow duct that contains cooling fluid in contact with the light source, the cooling fluid duct having a light transmissive region and a light reflective region disposed to reflect light from the light source through the light transmissive region to be received by a light guide.

2. Dermatological treatment apparatus according to claim 1 in which the cooling fluid duct is formed from a hard, heat-resistant, transparent material.

3. Dermatological treatment apparatus according to claim 2 in which the fluid duct is formed of glass.

4. Dermatological treatment apparatus according to claim 2 in which the fluid duct is formed of quartz.

5. Dermatological treatment apparatus according to any preceding claim in which the cooling fluid duct has a tubular section.

6. Dermatological treatment apparatus according to claim 5 in which the cooling fluid duct is generally cylindrical.

7. Dermatological treatment apparatus according to any one of claims 1 to 5 in which the cooling fluid duct has a cross-sectional shape selected to confer advantageous optical properties upon the reflective region.

8. Dermatological treatment apparatus according to claim 7 in which the cooling fluid duct has a cross-section that is in part approximately parabolic.

9. Dermatological treatment apparatus according to any preceding claim in which the light reflective region is constituted by a region of the cooling fluid flow duct coated with a reflective coating.

10. Dermatological treatment apparatus according to claim 9 in which the reflective coating includes a reflecting layer of reflective metal, such as silver, aluminium, or mixture of those and/or other metals.

11. Dermatological treatment apparatus according to claim 9 or claim 10 in which the reflective coating includes one or more layers in addition to the said reflecting layer.

12. Dermatological treatment apparatus according to claim 11 in which such additional layers contribute to properties of the reflective coating, the properties including any or all of its physical robustness, its reflectiveness, its opacity, and/or its ability to disperse heat.

13. Dermatological treatment apparatus according to claim 12 in which the additional layers include a layer of paint that serves to protect underlying reflective layers.

14. Dermatological treatment apparatus according to claim 9 in which the reflective coating comprises a layer of silver metal deposited upon the material of the cooling fluid duct, a layer of copper deposited upon the layer of silver, and a protective paint layer applied to the copper layer.

15. Dermatological treatment apparatus according to claim 9 in which the reflective coating comprises a layer of silver metal deposited upon the material of the cooling fluid duct, and a protective paint layer applied to the silver layer.

16. Dermatological treatment apparatus according to any preceding claim in which the cooling fluid is water.

17. Dermatological treatment apparatus substantially as herein described with reference to the accompanying drawings.

18. A dermatological treatment unit comprising apparatus according to any preceding claim contained within a treatment head, and a control unit for controlling operation of the apparatus.

19. A dermatological treatment unit according to claim 18 in which the control unit is connected to the treatment head by a cable through which electrical signals and/or cooling fluid is conveyed.

20. A dermatological treatment unit substantially as herein described with reference to the accompanying drawings.

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Application No:	GB 0008624.9	**Examiner:**	Dr Jeremy Kaye
Claims searched:	1-20	**Date of search:**	19 March 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): A5R (REHR); F4R (RPM)

Int Cl (Ed.7): A61N 5/00, 5/01, 5/06; F21V 29/00

Other: Online: EPODOC, WPI, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	WO 98/52645 A1	(GUSTAFSSON) p.2, ll.1-31; p.5, l.17 - p.6, l.27; p.8, ll.5-17; p.9, l.19 - p.11, l.1; figures 1 and 2.	1-6, 9-11, 16, 18, 19
X	WO 97/14915 A1	(THE REGENTS OF U. CAL) p.5, ll.3-9; p.6, ll.3-10; figures 1, 2 and 3.	1, 5, 6, 16, 19
X	JP 58049435	(TOSHIBA) see PAJ abstract and figure	1
X	JP 56155765	(USHIO) see PAJ abstract and figure	1
X	DD 257200 A	(HECHT ET AL.) see abstract	1
A	WPI Abstract Accession No. 1997-364353/34 & CN 1108959A (HAO) (see abstract).		1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		

Treatment of Facial Telangiectasia Using the VersaPulse® Variable Pulse Width Frequency Doubled Neodymium:YAG Laser: A Case Report

Robert M. Adrian, M.D., F.A.C.P.

Abstract

Although flashlamp pumped pulsed dye lasers are quite effective in the treatment of facial telangiectasia, the resultant postoperative purpura is a major obstacle in patient acceptance of this procedure. (Figure 2)

Based on theoretical and clinical data developed by Dierickx et al at Wellman Laboratories, Coherent Medical Group (Palo Alto, CA) has introduced a new variable pulse width 532 nm frequency-doubled Nd:YAG laser for the treatment of vascular lesions. Pulse widths between 2 mm seconds and 10 milliseconds are available with fluences of up to 38 J/cm^2 capable of being delivered by means of a 2 to 10 mm variable spot handpiece. Energy is delivered to the cutaneous surface through a "chilled tip" cooled by means of circulating water. (Figure 1) Preliminary histologic studies do not show blood vessel rupture which correlates with the lack of postoperative clinical purpura.

The following case reports describe two patients with facial telangiectasia treated with this laser.

Case I

AL is a 68-year-old male with a history of multiple facial telangiectasia secondary to chronic sun exposure. Since postoperative cosmetic appearance was of concern to the patient, he was treated using the VersaPulse laser at 532 nm. A fluence of 9.5 J/cm^2 was delivered through a 4 mm spot size with a chilled tip temperature of 5.5° C. Figures 3a, 3b and 3c show pre-operative, immediately post-operative and one month post-operative results. The lack of purpura is clinically evident and permits resumption of normal work and social activity.

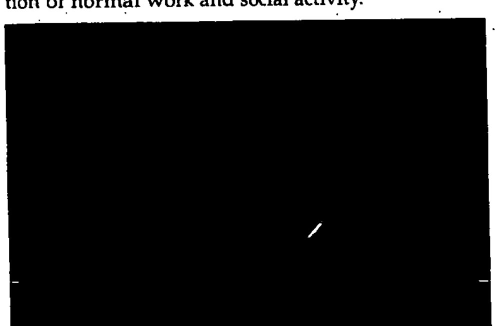

Figure 1
Chilled Tip cools skin during laser treatment.

Case II

EC is a 48-year-old female with a large spider telangiectasia of the nose. Complete response was achieved with a single treatment using a fluence of 9.5 J/cm^2, delivered through a 4.0 mm spot size with a chilled tip temperature of 5.5°C. Figures 4a, 4b and 4c show pre-operative, immediately post-operative and three weeks post-operative results. The lack of purpura was greatly appreciated by the patient since she was able to continue normal social and business activities.

Discussion

The VersaPulse laser appears to offer distinct clinical advantages when compared to currently available vascular lasers. It appears to be at least as efficacious as the pulsed dye laser without postoperative ecchymosis, which is a major drawback when using the pulsed dye laser. In addition, the use of the chilled tip greatly reduces patient discomfort and reduces post-operative epidermal damage. The VersaPulse laser appears to be a very effective tool for the cosmetic treatment of facial blood vessels. The lack of clinical purpura and reduced discomfort appear to be distinct advantages when compared to other currently available lasers.

Reference:
Dierickx, C. C., J. M. Casparian, V. Venugopalan, W. A. Farinelli and R. R. Anderson. 1994. Thermal Relaxation of Port-Wine Stain Vessels Probed In Vivo: The Need for 1-10 Millisecond Laser Pulse Treatment. *Journal for Investigative Dermatology* 105:1

Robert M. Adrian, M.D., F.A.C.P. is Clinical Assistant Professor, Georgetown University Medical School and Director of Center for Laser Surgery, Washington, D.C.

EC

Figure 2 Purpura immediately after treatment with pulsed dye laser.

Figure 3a Case I, Pre-operative

Figure 3b Case I, immediately Post-operative

Figure 3c Case I, one month Post-operative

Figure 4a Case II, Pre-operative

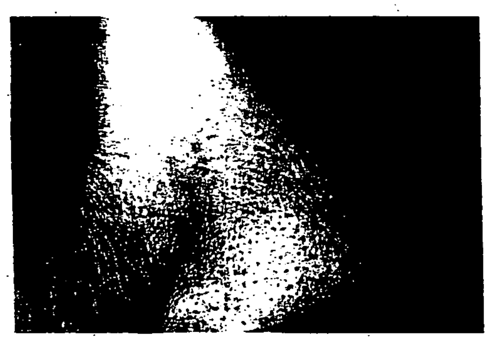

Figure 4b Case II, immediately Post-operative

Figure 4b Case II, three weeks Post-operative

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